B **B3B026** **Total pages:2**

Reg No._____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION, JANUARY 2017

Course Code**: CH201**

Course Name**: CHEMICAL PROCESS CALCULATIONS (CH)**

Maximum Marks: 100 Time: 3 hours

PART A

Answer any two full questions. Each question carries 15 marks

1. a) Convert 20 gallon/hr to m^3/s. (2)

   b) A gas mixture has the following composition by volume. Find the average molecular weight of the gas mixture and the composition by weight. Ethylene – 30.6 %, Benzene – 24.5 %, Oxygen – 1.3 %, Methane – 15.5 %, Ethane – 25.1 %, Nitrogen – 3.1 % (7)

   c) An aq. solution of K_2CO_3 is prepared by dissolving 43 kg K_2CO_3 in 100 kg water at 293 K. The density of the solution is 1.3 kg/l. Find the molarity, normality and molality of the solution. (3)

   d) Distinguish between unit operations and unit processes? Cite with examples. (3)

2. a) Calculate the specific volume of oxygen at 100 bar and 300 K using ideal gas law and van der Waal's equation. Take a = 0.1378 Nm^4/mol^2 and b = 3.18 x 10^{-5} m^3/mol. (9)

   b) Calculate the average molecular weight of air. (6)

3. a) A natural gas has the following composition in mole%. Calculate wt % and average molecular weight. Methane – 83.5 % , Ethane – 12.5 %, Nitrogen – 4 % (6)

   b) State and prove Amagat's law. (3)

   c) Write down Redlich-Kwong Equation. Explain all the terms. (3)

   d) Write a note on pseudo critical property with examples. (3)

PART B

Answer any two full questions. Each question carries 15 marks.

4. a) Derive Clausius-Clapeyron equation. Mention its application. (5)

   b) Moist air contains 0.0109 kg water vapour per cubic metre of the mixture at 300 K and 101.3 kPa. Calculate the partial pressure of water, the relative saturation, absolute humidity of the air and percent saturation.

   The vapour pressure of water in kPa is approximated by the Antoine equation as

   $\ln P^S = 16.26 - \dfrac{3799.887}{T - 46.85}$ where T is in K. (10)

5. a) A distillation column separates 10,000 kg/hr of a 50 % benzene-50 % toluene mixture. The product, D recovered from the condenser at the top of the column contains 95 % benzene and the bottom, W contains 96 % toluene. The vapour stream, V entering the condenser from the top of the column is 8000 kg/hr. A portion of the distillate is recycled. Assuming the compositions of V, R and D are identical find the reflux ratio. (10)

   b) Wood containing 40 % moisture is dried to 5 % moisture. What mass of water in kilograms is evaporated per kg of dry wood? (5)

6. a) Air at 288 K and 100 kPa contains 1 kg of water vapour. Water is completely removed by adsorbing on silica gel. The dry air after adsorption measures 1000 m^3 at 108 kPa and 293 k. What was the relative humidity of air before adsorption? The vapour pressure of water at 288 K is 1.7 kPa. (9)

   b) Explain Recycle, bypass and purge operations with examples. (6)

PART C

Answer any two full questions. Each question carries 20 marks

7. In the Deacon process for the manufacture of chlorine, a dry mixture of HCl gas and air is passed over a hot catalyst, which promotes oxidation of the acid. 30 % excess air is used. Calculate the weight of air supplied per kg of acid, the composition (wt %) of entering gases assuming that 60 % of the acid is oxidized in the process and the composition (wt %) of the gases leaving. (20)

8. a) Explain Standard heat of formation, Kopp's rule and Hess's law of constant heat summation. (5)

   b) How many Joules are needed to heat 60 kg of sulphur trioxide from 273.16 K to 373.16 K? (15)

$$Cp = 34.33 + 42.86x10^{-3}T - 13.21x10^{-6}T^2$$

9. A synthesis gas consisting of 24.3 % N_2, 75.2 % H_2 and 0.5 % Ar is fed to an ammonia converter mixed with the recycled stream. The single pass conversion of nitrogen is 10 %. The unconverted gases leaving the reactor are separated and returned to the reactor along with fresh feed. In order to keep the concentration of Ar in the recycled stream below 1 %, a portion of the recycled stream is purged off. For 100 kg of fresh synthesis gas, determine the moles of recycle stream, the moles of purge stream and the amount of ammonia produced in kmol. (20)